First Coherent Synchrotron Radiation Scientific Results: Measuring the Josephson Plasma Resonance in $Bi_2Sr_2CaCu_2O_8$

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In a collaboration between the ALS and BESSY to make a first demonstration of the powerful new scientific opportunities of Coherent Synchrotron Radiation (CSR), we have successfully measured the Josephson Plasma Resonance (JPR) in the high-temperature superconductor $Bi_2Sr_2CaCu_2O_8$ (Bi-2212). These optical reflectivity measurements were performed using a dedicated low-alpha mode of operation at the BESSY synchrotron which produces stable CSR.

Figure 1 shows a comparison of the measured CSR source intensity to conventional thermal sources -- there is at least 4 orders of magnitude greater intensity at the lowest, sub-THz frequencies. CSR therefore opens a new window to lower frequencies for optical measurements and bridges the gap between microwave and optical techniques.

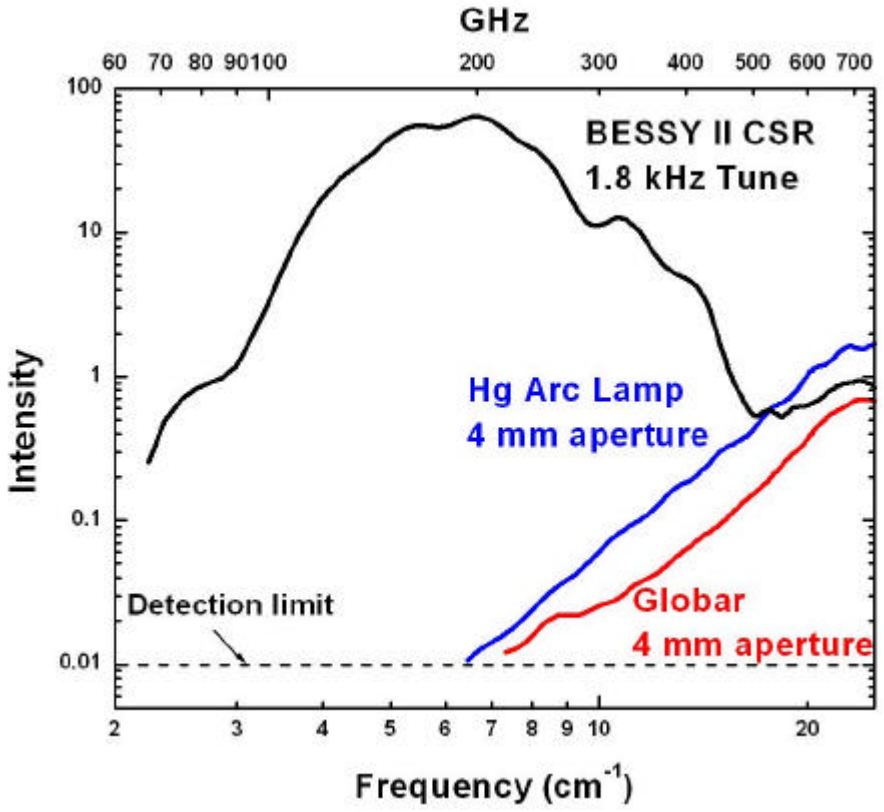

Figure 1. Measured far-IR intensity of the BESSY CSR source compared to the intensity for conventional thermal far-IR sources. These intensity measurements were performed with an open sample path in a Bruker 66v/S FTIR interferometer and a Si bolometer detector operated at a temperature of 1.6 K.

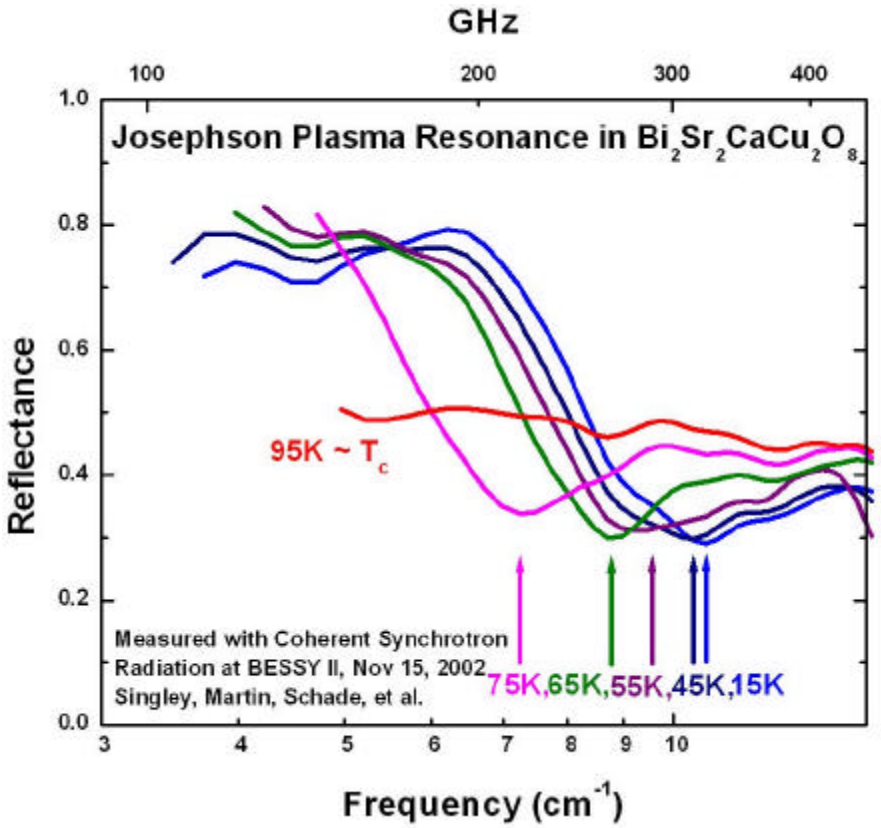

Figure 1. Measured c-axis polarized reflectance of Bi-2212 as a function of temperature. The reflectivity edge clearly shows the JPR, with the approximate location of the screened JPR frequency denoted by arrows for each temperature below T_C.

Figure 2 shows the first scientific results using this CSR source. Due to the absence of measurable intensity in the sub-THz region from conventional far-IR sources, the JPR in the highly anisotropic Bi-2212, one of the most studies high-T_c superconductors, has never been measured. The success of this measurement was only possible due to the ultra-bright CSR intensities in this critical wavelength region. The figure shows the sample reflectivity as a function of temperature with the arrows indicating the frequency of the JPR at each temperature. As expected, this resonance decreases in frequency as the temperature increases and is completely absent above T_c.

We are excited that with only two shifts of CSR beamtime we were able to achieve a significant new scientific result. A full analysis of this data is being submitted for publication in 2003.

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